Net primary productivity of macrophyte communities after six growing seasons in experimental planted and unplanted marshes

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Introduction

One of the wetland functions estimated every year in the experimental marshes at the ORWRP is the net primary productivity (NPP) of the wetland macrophyte communities. Productivity indicates the general health of the wetland community and its trophic status. NPP is an indicator of biomass that can be utilized by heterotrophs. The assessment of the vegetation in a newly created wetland through the measurement of NPP, coupled with estimations of plant structure such as diversity and cover, provide essential data on the functional capacity of the macrophyte communities.

Direct measurements of primary productivity were first made at the experimental wetland basins at the Olentangy River Wetland Research Park (ORWRP) in 1997. This study in 1999 represents the third set of such measurements. Before 1997 (the fourth growing season), harvesting was not considered a good option when vegetation was just getting started in the basins. By the fourth year (1997), we determined that limited harvesting of plants to estimate the productivity of the system was possible without affecting the general succession and productivity of the overall system.

Methods

Net aerial primary productivity (NAPP) was estimated by harvesting peak biomass at the end of the growing season (end of August 1999) at selected stations in the two experimental wetland basins at the ORWRP (Figure 1). The same stations established from the boardwalk system in 1997 (Mitsch and Bouchard, 1998) and 1998 (Bouchard and Mitsch, 1999) were visited again in 1999. To avoid harvesting the exact same spots, quadrats were 2 m—and not 1 m—from the outer edge of boardwalk in 1999 and were 1 m from the edge of the boardwalk. In each station, we used 1-m^2 quadrats to delineate the area of vegetation for harvest. When no vegetation was present, the station was skipped. Overall, there are potentially 21 stations in each wetland. Only 16 quadrats are sampled annually in each wetland, 8 in the northern or inflow half of each basin and 8 in the southern or outflow half of each basin. In each quadrat, plants were clipped at ground level (water was lowered in the wetlands to make sampling easier and to allow rapid recovery of the clipped plants). Samples were segregated both by quadrat and by species, placed in plastic bags and weighed in the field with a hanging balance (accuracy ± 40 g). Sub-samples were taken to the laboratory where both wet weight (WW) and dry weight (DW, dried at 105°C for 48 hours) were determined to estimate dry/wet ratios. Average ratios for each species were multiplied by total wet weight of each species at each quadrat to estimate total dry weight production. The sum of all species in a quadrat was the estimated peak biomass and hence annual net above-ground primary productivity (NAPP).

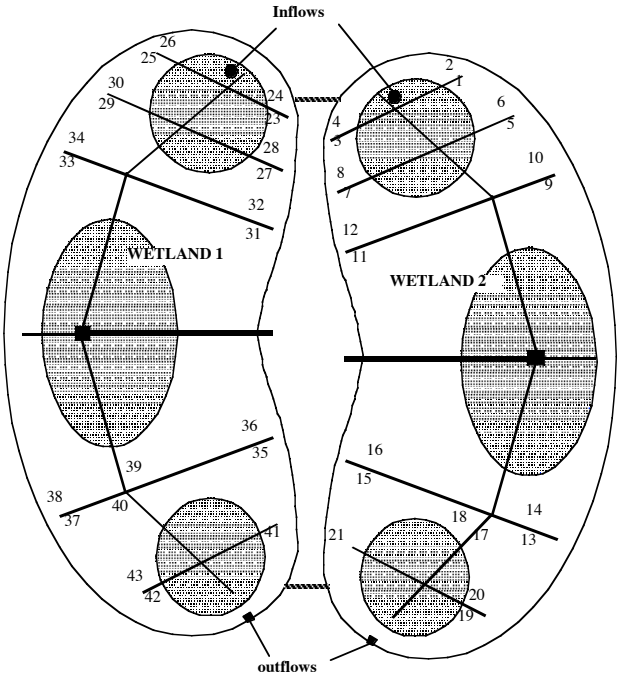

Figure 1. Sampling stations used for macrophyte harvesting, August 1999.

Results and Discussion

Comparison of basins and location

In 1999, NAPP was 657±76 g m^{-2} yr^{-1} in Wetland 1, the planted wetland, and 1023±94 g m^{-2} yr^{-1} in Wetland 2 (Table 1). Comparing the two basins overall, productivity was higher in the colonizing Wetland 2 than in the planted Wetland 1 six growing seasons after planting. The

productivity was significantly higher near the outflow (1256 ± 130 g m^{-2} yr^{-1}) than the inflow (790 ± 75 g m^{-2} yr^{-1}) in the naturally colonizing Wetland 2 (n = 8, α=0.05) but the same could not be said for the planted Wetland 1 (Figure 2). Comparing the two basins, productivity was higher in Wetland 2 for the outflow samples but not for the inflow samples (t-test, n = 8, α=0.05).

Dry/wet ratios

As in the previous annual report, dry/wet ratios of individual plants are provided (Table 2). Dry/wet ratios ranged from about 33-35% for *Schoenoplectus* (was 30-31% in 1998) to about 13 % for *Sagittaria (was* 11% in 1998). *Typha* consistently had a dry/wet ratio of 26% in 1999 compared to a ratio of 23-24% in 1998.

Comparison with previous years

In 1998, NAPP was 729±55 g m^{-2} y^{-1} in Wetland 1 and 1127±64 g m^{-2} yr^{-1} in Wetland 2 for the areas covered by macrophytes (Figure 3; Bouchard and Mitsch, 1999). The productivity in Wetland 2 was significantly higher than the productivity of Wetland 1 (t-test, n=16, a=0.05). In 1999, the macrophyte productivity decreased in both wetlands (10% and 9% in Wetlands 1 and 2, respectively). These differences between years are probably not ecologically significant.

Species dominating the productivity

As was the case in 1998, the species harvested in the two basins indicate differences that still linger from the planting of 1994 (Figure 4). Wetland 1, which was planted with 12

Table 1. Estimated net above-ground primary productivity (NAPP) of macrophyte communities in the Olentangy River experimental wetlands, late August 1999, based on peak biomass harvest. Numbers are ave±std error [# samples].

	Total NAPP (g/m^2-yr)	Inflow NAPP (g/m^2-yr)	Outflow NAPP (g/m^2-yr)
Wetland 1	657±76 [16]	601±126 [8]	714±90 [8]
Wetland 2	1023±94 [16]	790±75 [8]	1256±130 [8]

Table 2. Dry/wet ratios (ave±std error (# samples)) of dominant macrophytes in the Olentangy River wetlands in 1999.

Species	Wetland 1	Wetland 2
S. tabernaemontani	0.353±0.005 (13)	0.334±0.005 (14)
S. fluviatilis	0.302±0.011 (4)	
Sagittaria latifolia	0.127±0.020 (4)	
Spar. eurycarpum	0.231±0.004 (11)	
Typha spp.	0.255±0.002 (4)	0.256±0.005 (15)

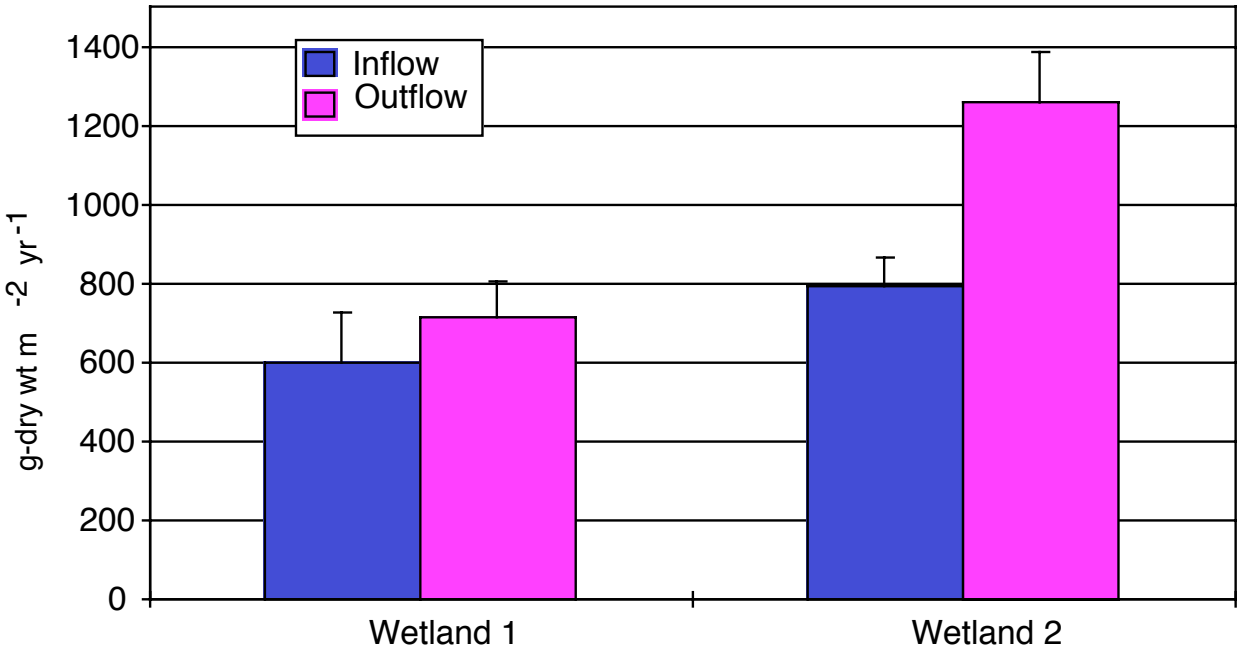

Figure 2. Net Aerial Primary Production in Wetland 1 and 2 in inflow and outflow areas for 1999.

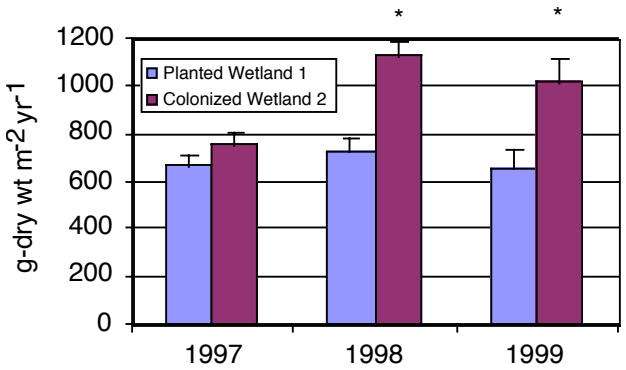

Figure 3. Net Aerial Primary Production for 1997-99 in the experimental wetlands. * indicates significant differences between the two wetlands (a=0.05).

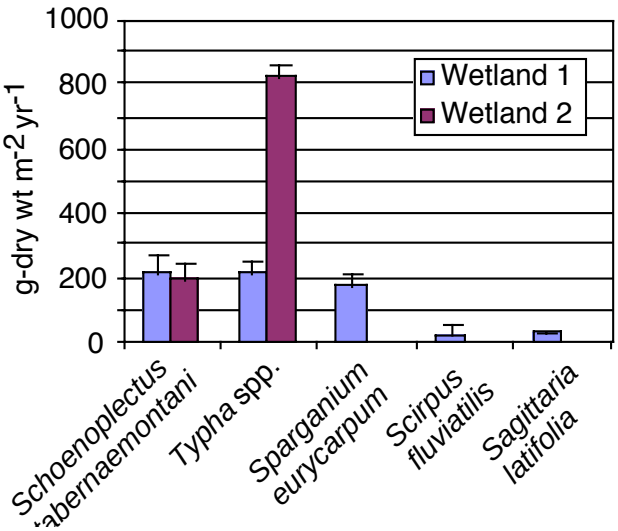

Figure 4. Distribution of peak biomass in August 1999 in the two experimental wetland basins. Four of the five species listed in Wetland 1 were planted in May 1994. Wetland 2 was dominated by *Typha.*

species in May 1994, had 5 taxa found in the quadrats that contributed to the above-ground productivity. Four of these taxa (*Schoenoplectus tabernaemontani, Sparganium eurycarpum, Scirpus fluviatilis* and *Sagittaria latifolia*) were planted in 1994 and these taxa represented 67% of the macrophyte above-ground productivity in the harvested quadrats in 1999. This was less dominant than in 1998 when 90% of the productivity was attributable to these species. Of these four introduced, the order of most important were *Schoenoplectus tabernaemontani* > *Sparganium* > *Scirpus fluviatilis* > *Sagittaria*. Colonizing *Typha* provided the remaining 33% of the above-ground productivity. *Typha* contribution to the wetland NAPP was 14% in 1997 and 10% in 1998 (Mitsch and Bouchard, 1998; Bouchard and Mitsch, 1999). *Typha* was found in only 4 quadrats in 1999 (Table 2) while the species was found in 5 quadrants in 1998 and 7 quadrats in 1997. The opposite pattern appeared with *Sparganium* which increased its co-dominance in Wetland 1, with the plant found in 11 quadrats in 1999, compared to 9 quadrats in 1998 and 7 in 1997.

Only two taxa (*Typha* spp. and *Schoenoplectus tabernaemontani)* contributed to the productivity in Wetland 2 and, of course, both were colonizers. Between 1997 and 1999, we observed a rapid increase of *Typha* dominance in Wetland 2. In 1997, *Typha* spp. contributed only 15% of the NAPP; in 1998, it contributed up to 48% of the production; in 1999 it contributed 81% of the NAPP.

Autochthonous carbon sources from macrophytes

Based on the above-ground productivity estimates and the estimates of vegetation cover presented elsewhere in this annual report (Mitsch et al., 2000 in this annual report; W1 = 5,311 m^2; W2 = 6,692 m^2), above-ground productivity by macrophytes is an estimated 3500 kg and 6800 kg in Wetlands 1 and 2 respectively. [This is calculated as the overall NAPP in Table 1 in this chapter multiplied by the "vegetation cover" in Mitsch et al., 2000]. These numbers are slightly higher than the 3300 kg and 5600 kg in Wetland 1 and Wetland 2, respectively calculated for 1998 but considerably higher than the estimates in 1997 of 2525 kg and 3130 kg in Wetland 1 and Wetland 2, respectively (Bouchard and Mitsch, 1999).

References

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Appendix A. Harvested wet weight of plants in ORW experimental wetlands, August 1999. Station locations are shown in Figure 1. Weights are kg wet wt/m^2.

Station	Schoenoplectus	Typha sp.	Sparganium	Scirpus fluv.	Sagittaria	Total
Wetland 2						
1	0.4	2.8	0.0	0.0	0.0	3.2
2	0.5	2.4	0.0	0.0	0.0	2.9
3	1.3	0.8	0.0	0.0	0.0	2.1
4	0.6	3.1	0.0	0.0	0.0	3.7
5	skipped					
6	1.2	0.4	0.0	0.0	0.0	1.5
7	skipped					
8	1.5	1.1	0.0	0.0	0.0	2.6
9	1.5	0.8	0.0	0.0	0.0	2.3
10	skipped					
11	0.0	4.1	0.0	0.0	0.0	4.1
12	skipped					
13	skipped					
14	0.0	5.1	0.0	0.0	0.0	5.1
15	0.3	3.9	0.0	0.0	0.0	4.1
16	0.1	4.2	0.0	0.0	0.0	4.4
17	0.1	6.7	0.0	0.0	0.0	6.7
18	0.3	7.2	0.0	0.0	0.0	7.5
19	0.6	2.4	0.0	0.0	0.0	3.0
20	0.2	3.1	0.0	0.0	0.0	3.3
21	0.8	3.3	0.0	0.0	0.0	4.1
TOTAL	9.2	51.4	0.0	0.0	0.0	60.6
AVERAGE	0.58	3.21	0.00	0.00	0.00	3.79
# OBSERV	16	16	16	16	16	16
Wetland 1						
23	0.2	0.0	2.0	0.2	2.00	4.4
24	0.0	0.0	0.5	0.6	0.00	1.1
25	0.0	0.0	2.0	0.0	0.00	2.0
26	0.0	0.0	0.2	0.3	0.86	1.4
27	skipped					
28	0.9	0.0	0.3	0.0	0.05	1.3
29	skipped					
30	1.7	0.0	0.2	0.0	1.59	3.5
31	0.4	2.7	0.0	0.0	1.18	4.3
32	skipped		0.0			
33	0.0	4.4	0.0	0.0	0.00	4.5
34	skipped					
35	0.7	1.5	0.5	0.0	0.0	2.8
36	0.1	4.9	0.0	0.0	0.0	5.0
37	0.2	0.0	2.3	0.0	0.0	2.5
38	skipped					
39	1.9	0.0	0.0	0.0	0.0	1.9
40	2.0	0.0	0.0	0.0	0.0	2.0
41	1.1	0.0	1.8	0.0	0.0	2.9
42	0.4	0.0	1.9	0.0	0.0	2.2
43	0.5	0.0	1.5	0.0	0.0	1.9
TOTAL	10.2	13.6	13.1	1.2	5.7	43.8
AVERAGE	0.64	0.85	0.82	0.07	0.35	2.74
# OBSERV	16	16	17	16	16	16

Appendix B. Laboratory-measured dry/wet ratios from sub-samples for species harvested in experimental wetlands in August 1999. *Schoenoplectus* = *Schoenoplectus tabernaemontani*; *S. fluviatalis* = *Scirpus fluviatalis*; *Sagittaria* = *Sagittaria latifolia*; *Sparganium* = *Sparganium eurycarpum*. Sampling stations (Stations) shown in Figure 1.

Wetland 1

St #	Species	Wet wt, g	Dry wt, g	Dry/wet
23	S. fluviatilis	94.1	26.5	0.282
24	S. fluviatilis	69.8	21.3	0.305
26	S. fluviatilis	21.3	7.1	0.333
33	S. fluviatilis	14.2	4.1	0.289
23	Sagittaria	25.5	4.2	0.165
26	Sagittaria	36.5	4.2	0.115
28	Sagittaria	47.8	3.6	0.075
30	Sagittaria	40.3	6.1	0.151
31	Sagittaria	12.3	2.1	0.171
23	Schoenoplectus	75.2	25.6	0.340
25	Schoenoplectus	45.6	16.5	0.362
28	Schoenoplectus	89.5	32.2	0.360
30	Schoenoplectus	54.2	18.9	0.349
31	Schoenoplectus	26.3	8.9	0.338
33	Schoenoplectus	58.7	19.8	0.337
35	Schoenoplectus	74.1	26.3	0.355
36	Schoenoplectus	25.6	10.2	0.398
37	Schoenoplectus	45.2	16.5	0.365
39	Schoenoplectus	36.5	12.3	0.337
40	Schoenoplectus	45.2	15.2	0.336
41	Schoenoplectus	29.6	11.2	0.378
42	Schoenoplectus	36.5	12.3	0.337
43	Schoenoplectus	45.1	16.5	0.366
23	Sparganium	56.3	13.2	0.234
24	Sparganium	57.4	11.9	0.207
25	Sparganium	12.3	2.9	0.236
26	Sparganium	23.6	5.2	0.220
28	Sparganium	45.2	10.1	0.223
30	Sparganium	56.3	11.9	0.211
35	Sparganium	87.9	21.3	0.242
37	Sparganium	78.4	18.6	0.237
41	Sparganium	45.6	11.4	0.250
42	Sparganium	36.9	8.5	0.230
43	Sparganium	41.1	10.2	0.248
31	Typha	23.5	6.1	0.260
33	Typha	56.3	14.5	0.258
35	Typha	54.1	13.6	0.251
36	Typha	63.2	15.9	0.252

Wetland 2

St #	Species	Wet wt, g	Dry wt, g	Dry/wet
1	Schoenoplectus	23.5	7.5	0.319
2	Schoenoplectus	56.5	19.8	0.350
3	Schoenoplectus	41.2	14.5	0.352
4	Schoenoplectus	25.6	9.2	0.359
6	Schoenoplectus	56.2	18.4	0.327
8	Schoenoplectus	51.2	16.5	0.322
9	Schoenoplectus	63.2	23.3	0.369
15	Schoenoplectus	48.7	15.6	0.320
16	Schoenoplectus	32.5	11.2	0.345
17	Schoenoplectus	41.3	13.2	0.320
18	Schoenoplectus	26.5	9.2	0.347
19	Schoenoplectus	23.2	7.5	0.323
20	Schoenoplectus	27.8	8.9	0.320
21	Schoenoplectus	36.6	11.2	0.306
1	Typha	32.1	7.5	0.234
2	Typha	25.6	6.5	0.254
3	Typha	54.5	13.2	0.242
4	Typha	89.6	21.3	0.238
6	Typha	87.4	20.3	0.232
8	Typha	101.2	25.4	0.251
9	Typha	23.6	5.9	0.250
11	Typha	25.6	7.4	0.289
14	Typha	56.5	16.5	0.292
15	Typha	45.2	11.4	0.252
16	Typha	65.3	16.5	0.253
17	Typha	54.2	13.5	0.249
18	Typha	41.2	9.8	0.238
19	Typha	36.5	8.9	0.244
20	Typha	54.2	15.6	0.288
21	Typha	45.6	12.5	0.274